US009238499B1

(12) **United States Patent**
Viviani et al.

(10) **Patent No.: US 9,238,499 B1**

(45) **Date of Patent: Jan. 19, 2016**

(54) **WAKESURFING BOAT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/746,125**

(22) Filed: **Jun. 22, 2015**

Related U.S. Application Data

(63) Continuation of application No. 14/676,305, filed on Apr. 1, 2015.

(51) **Int. Cl.**
B63B 1/32 (2006.01)
B63B 1/04 (2006.01)

(52) **U.S. Cl.**
CPC ***B63B 1/042*** (2013.01)

(58) **Field of Classification Search**
USPC 114/288, 274, 271
IPC B63B 1/20,1/042
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

652,876	A	7/1900	Andrade
1,204,355	A	11/1916	Hickman
1,316,762	A	9/1919	Bigelow
1,620,349	A	3/1927	Hickman
1,644,725	A	10/1927	Hickman
1,670,623	A	5/1928	Hickman
1,681,342	A	8/1928	Hickman
2,285,959	A	6/1942	Dubay
2,423,796	A	7/1947	Platt
2,515,005	A	7/1950	Hickman
D197,099	S	12/1963	Torreson

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 466 382 A1	1/1992
EP	1075415 B1	2/2001

(Continued)

OTHER PUBLICATIONS

European Search Report for Application No. 12196282.3-1754; Mar. 27, 2013; 8 pages.

(Continued)

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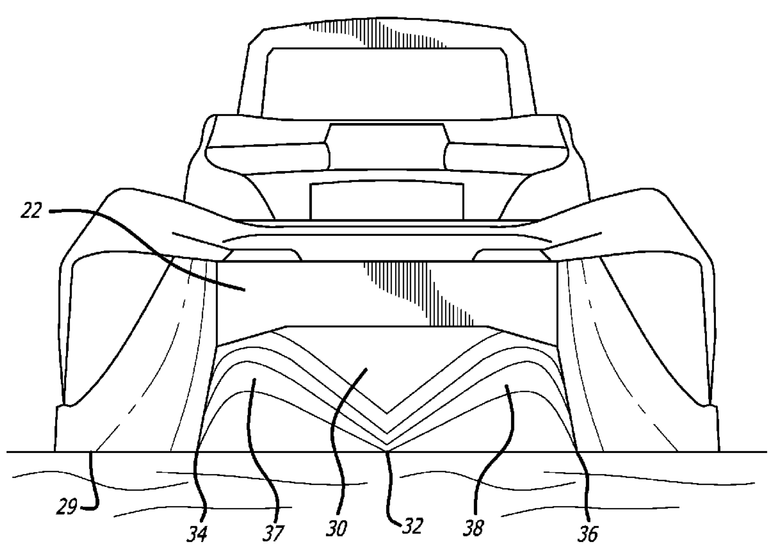
(57) **ABSTRACT**

A wakesurfing boat for creating a wave suitable for surfing in the wake of the boat. A length to beam (L/B) ratio of 3.21 combined with a rounded hull bottom proximate the transom minimizes losses in the wake wave. Elliptical arcuate portions extending from starboard and port points on the transom to selected positions on the respective starboard and port bulwarks further minimize losses in the wake wave. The hull bottom defines an M-shaped portion and a V-shaped portion. A propulsion system includes an exhaust pipe projecting from the hull bottom below the waterline, with an exhaust opening forward of the transom. A propeller has a hub and at least three blades. A blade area, defined by a sum of the area of the blades, is larger than 70% of a disc area, defined by a sum of the hub and the blades.

19 Claims, 14 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

3,191,572	A	6/1965	Allen
3,200,782	A	8/1965	Walden et al.
3,330,239	A	7/1967	Dornak
3,342,154	A	9/1967	Le Marec
3,503,358	A	3/1970	Moesly
D219,555	S	12/1970	Field
D219,795	S	1/1971	Field
3,675,605	A	7/1972	Knerr
3,709,179	A	1/1973	Payne
3,797,437	A	3/1974	Cowles
3,800,725	A	4/1974	L'Heureux
3,902,445	A	9/1975	Stolk
4,192,248	A	3/1980	Moyer
4,478,166	A	10/1984	Sorensen
D301,573	S	6/1989	Fuller
D302,969	S	8/1989	Pipkorn
D306,631	S	3/1990	Aguilar
4,922,844	A	5/1990	Solia
D318,041	S	7/1991	Meredith
5,140,930	A	8/1992	Lund
5,231,949	A	8/1993	Hadley
5,265,554	A	11/1993	Meredith
5,351,641	A	10/1994	Robson
D355,881	S	2/1995	Carlson
5,419,274	A	5/1995	van Diepen
5,427,048	A	6/1995	Takeuchi
5,458,078	A	10/1995	Perette
5,474,014	A	12/1995	Russell
5,526,762	A	6/1996	Kiley
5,549,071	A	8/1996	Pigeon et al.
D382,850	S	8/1997	Schmidt
5,655,473	A	8/1997	Arvilla
5,664,910	A	9/1997	Lochtefeld et al.
5,718,184	A	2/1998	Holland
D400,156	S	10/1998	Duvenage et al.
5,860,384	A	1/1999	Castillo
5,860,766	A	1/1999	Lochtefeld et al.
D405,411	S	2/1999	Schmidt
D418,104	S	12/1999	Bove
6,044,708	A	4/2000	Hirosawa
6,047,657	A	4/2000	Cox
6,105,527	A	8/2000	Lochtefeld et al.
6,192,819	B1	2/2001	Larson et al.
6,250,245	B1	6/2001	Robinson et al.
6,293,216	B1	9/2001	Barsumian
6,314,903	B2	11/2001	Robinson et al.
6,374,762	B1	4/2002	Larson et al.
6,526,903	B2	3/2003	Robinson et al.
6,604,478	B2	8/2003	Barsumian
6,708,642	B1	3/2004	Taylor
6,868,798	B2	3/2005	Robinson et al.
6,941,884	B2	9/2005	Moore
6,983,713	B1	1/2006	Robinson et al.
7,063,031	B2	6/2006	Earl, Jr. et al.
7,093,553	B2	8/2006	Robinson et al.
7,252,047	B1	8/2007	Baucom, Jr.
7,305,926	B2	12/2007	Seider
7,316,193	B1	1/2008	Greenbaum
D570,278	S	6/2008	Horais
7,418,915	B2	9/2008	Campbell
D581,340	S	11/2008	Fafard et al.
7,458,332	B2	12/2008	Wilson et al.
D595,204	S	6/2009	Robinson
7,578,250	B2	8/2009	Baker
7,625,153	B2	12/2009	Sauerbier
7,677,190	B2	3/2010	Miller
7,677,192	B2	3/2010	Scism et al.
7,699,016	B2	4/2010	Larson et al.
D643,357	S	8/2011	Moore et al.
8,011,313	B2	9/2011	Sasayama
D651,551	S	1/2012	Moore et al.
8,109,221	B2	2/2012	Graf et al.
8,281,730	B2	10/2012	Munson
8,590,475	B2	11/2013	Viviani et al.
8,857,364	B2	10/2014	Viviani et al.
2003/0041791	A1	3/2003	Chollet et al.
2004/0129192	A1	7/2004	Guerard
2009/0308300	A1	12/2009	Baker
2010/0275829	A1	11/2010	Sporsheim
2011/0017115	A1	1/2011	Olofsson
2013/0145978	A1	6/2013	Viviani

FOREIGN PATENT DOCUMENTS

JP	1-95991	4/1989
WO	WO 98/36961 A1	8/1998

OTHER PUBLICATIONS

U.S. Appl. No. 14/676,305, filed Apr. 2015, Viviani et al.

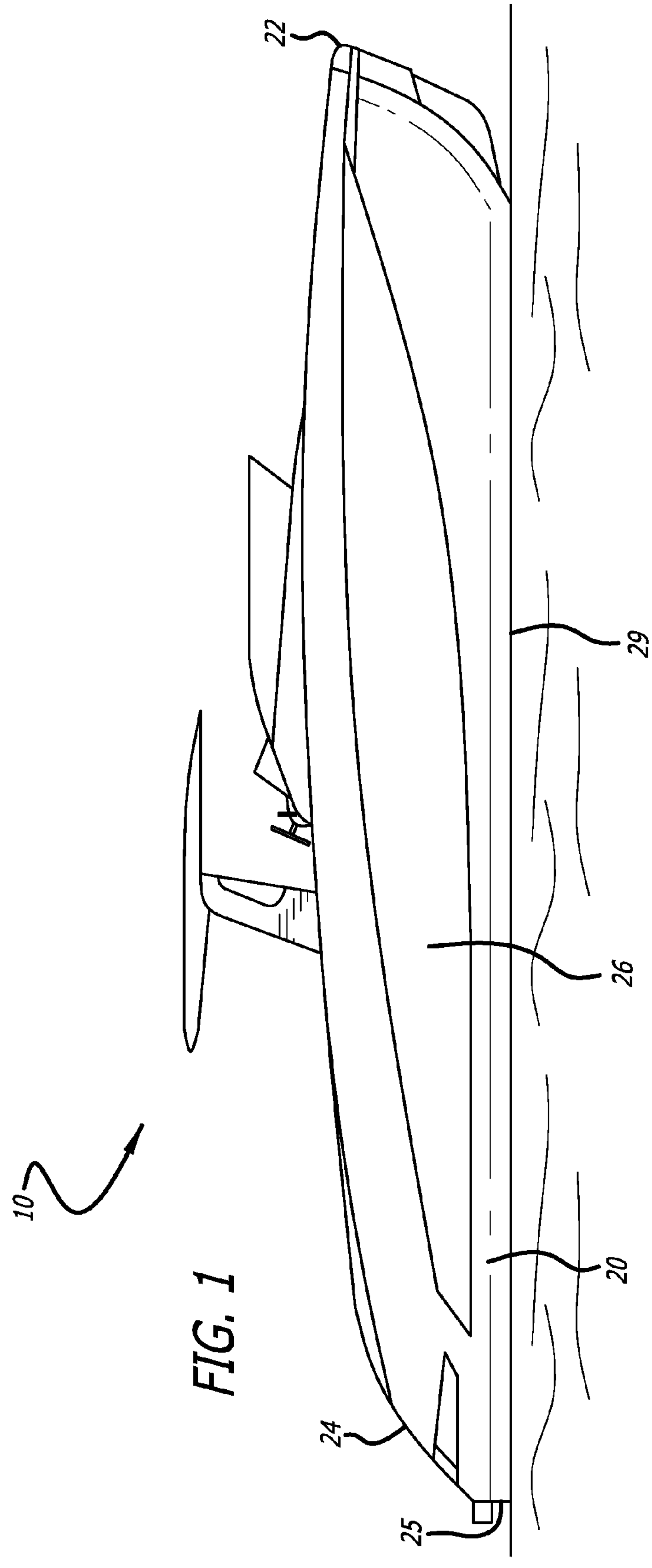


FIG. 1

FIG. 2

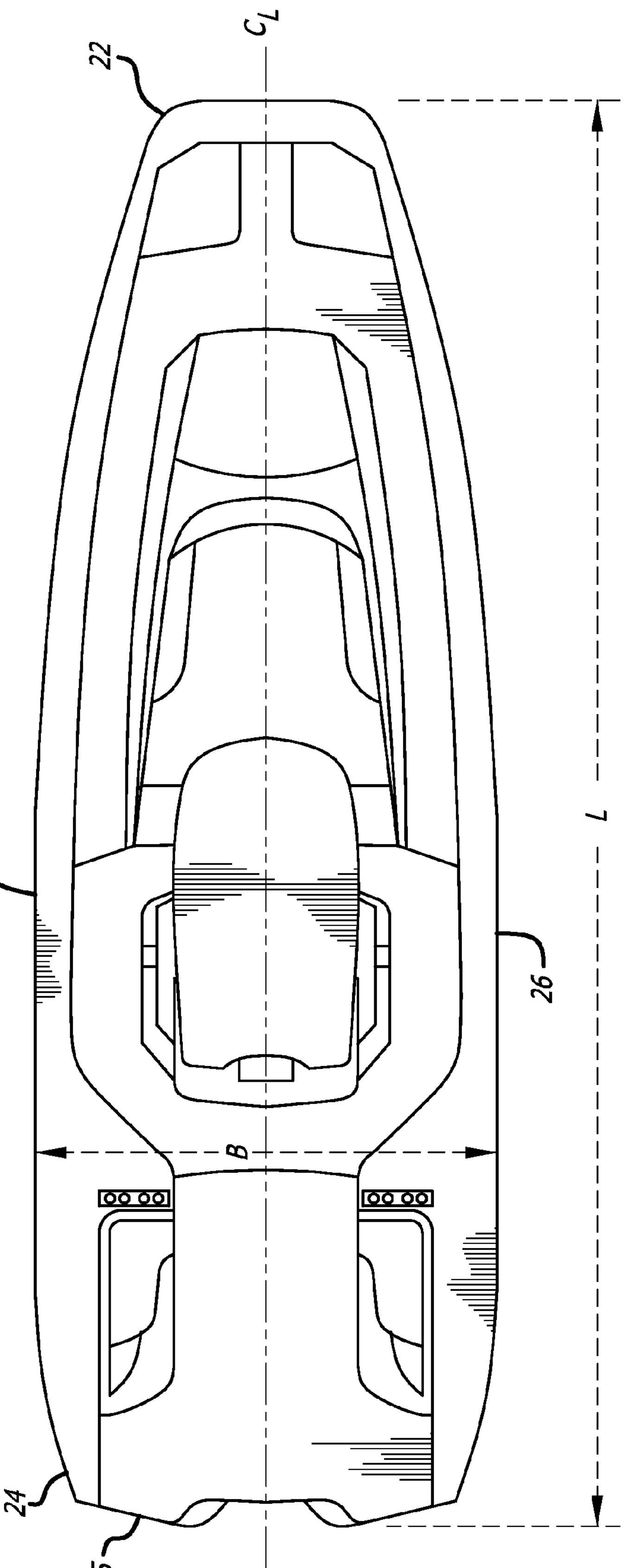
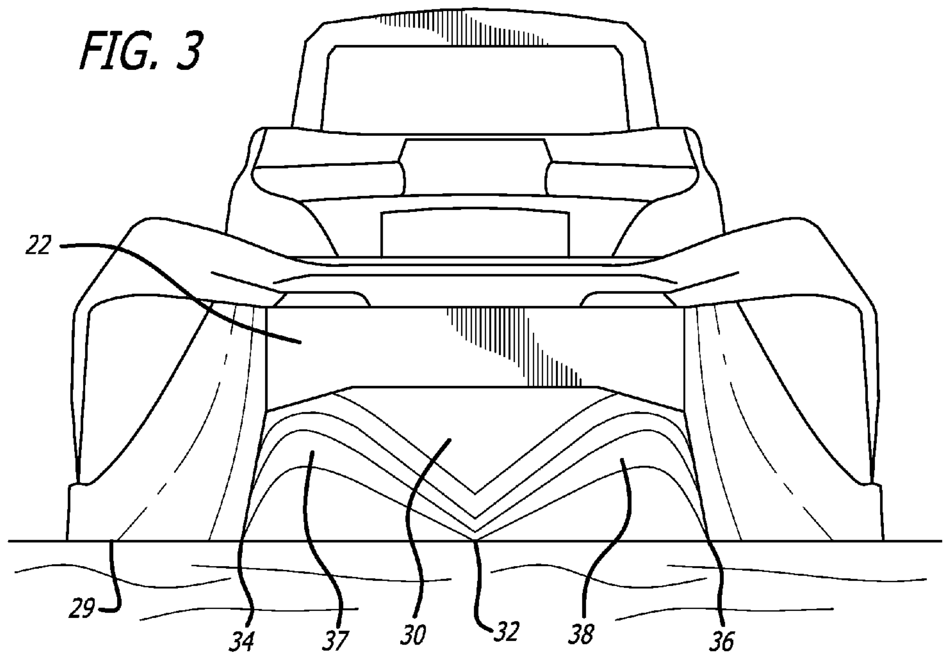


FIG. 3



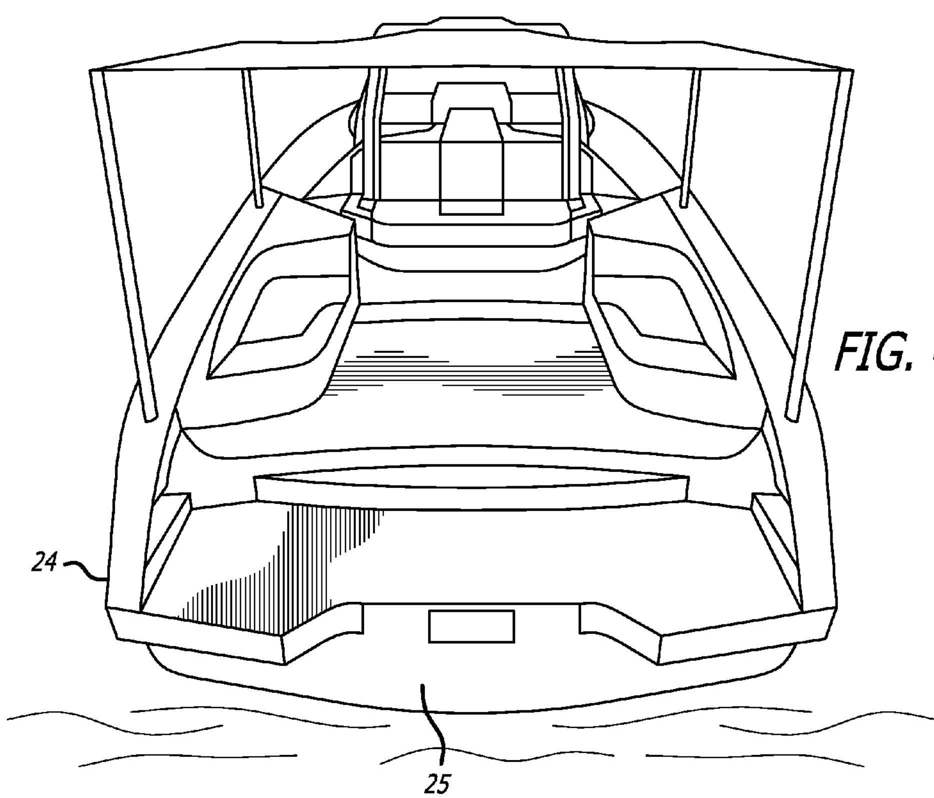
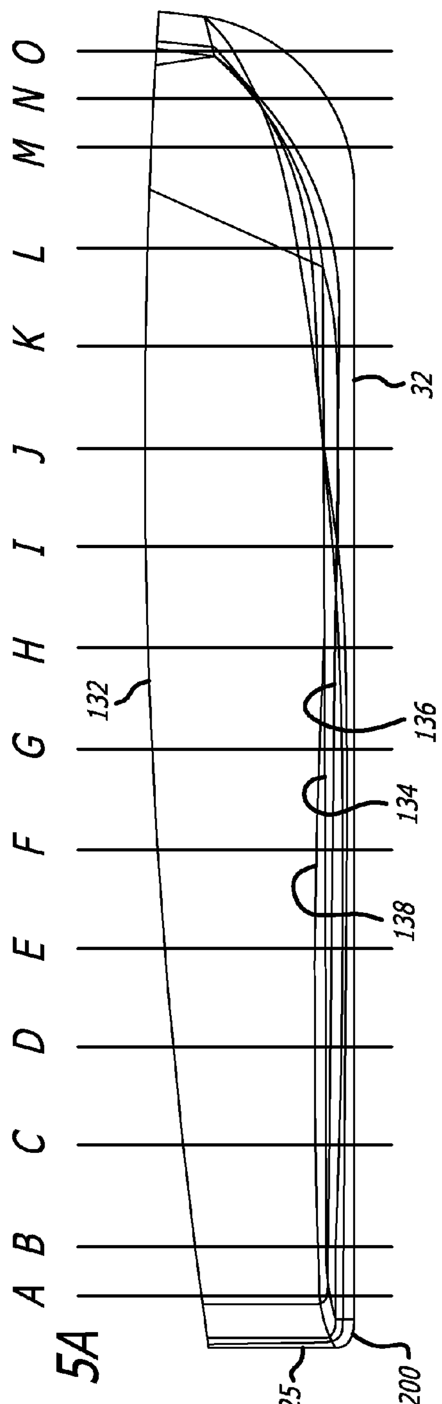
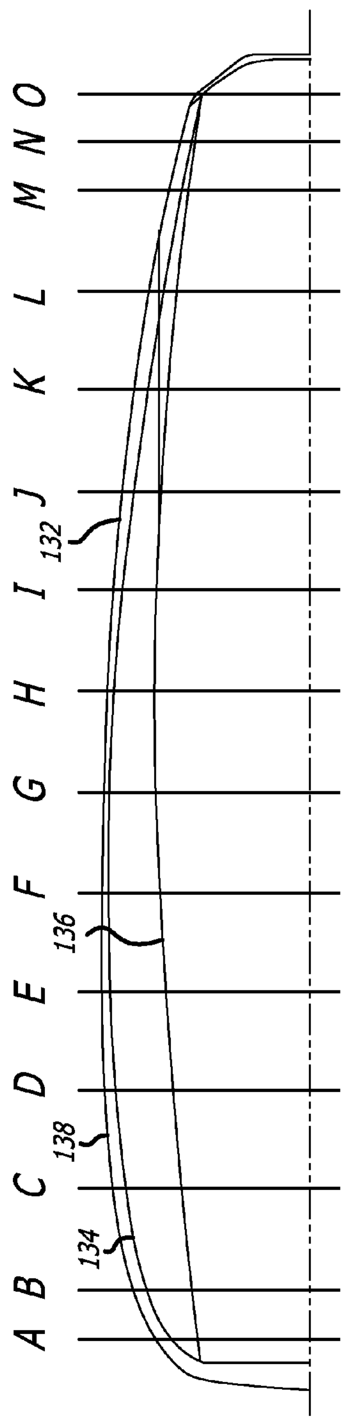


FIG. 4



A B C D E F G H I J K L M N O
132
32
136
134
138
25
200

FIG. 5A



A B C D E F G H I J K L M N O
132
136
138
134

FIG. 5B

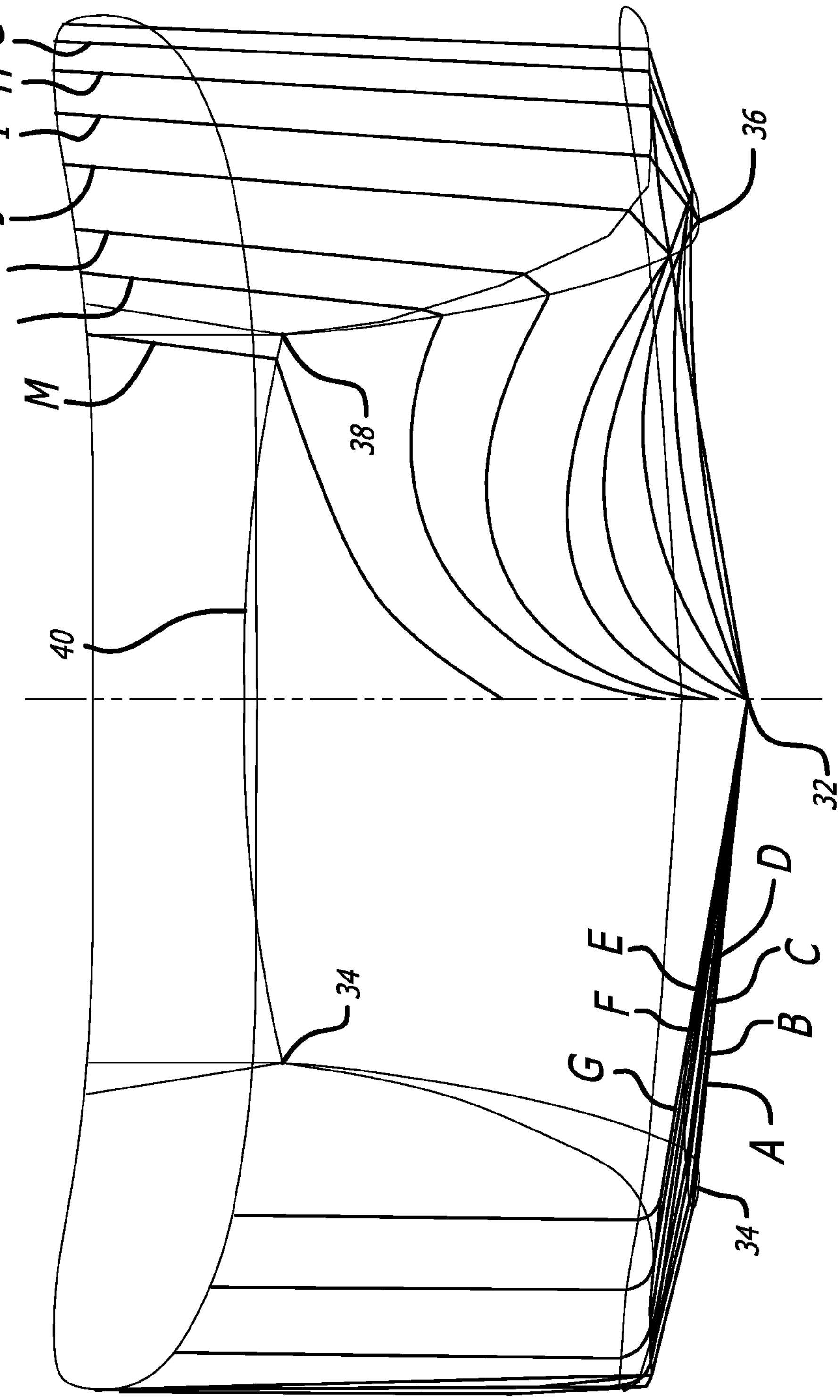


FIG. 6

FIG. 7A

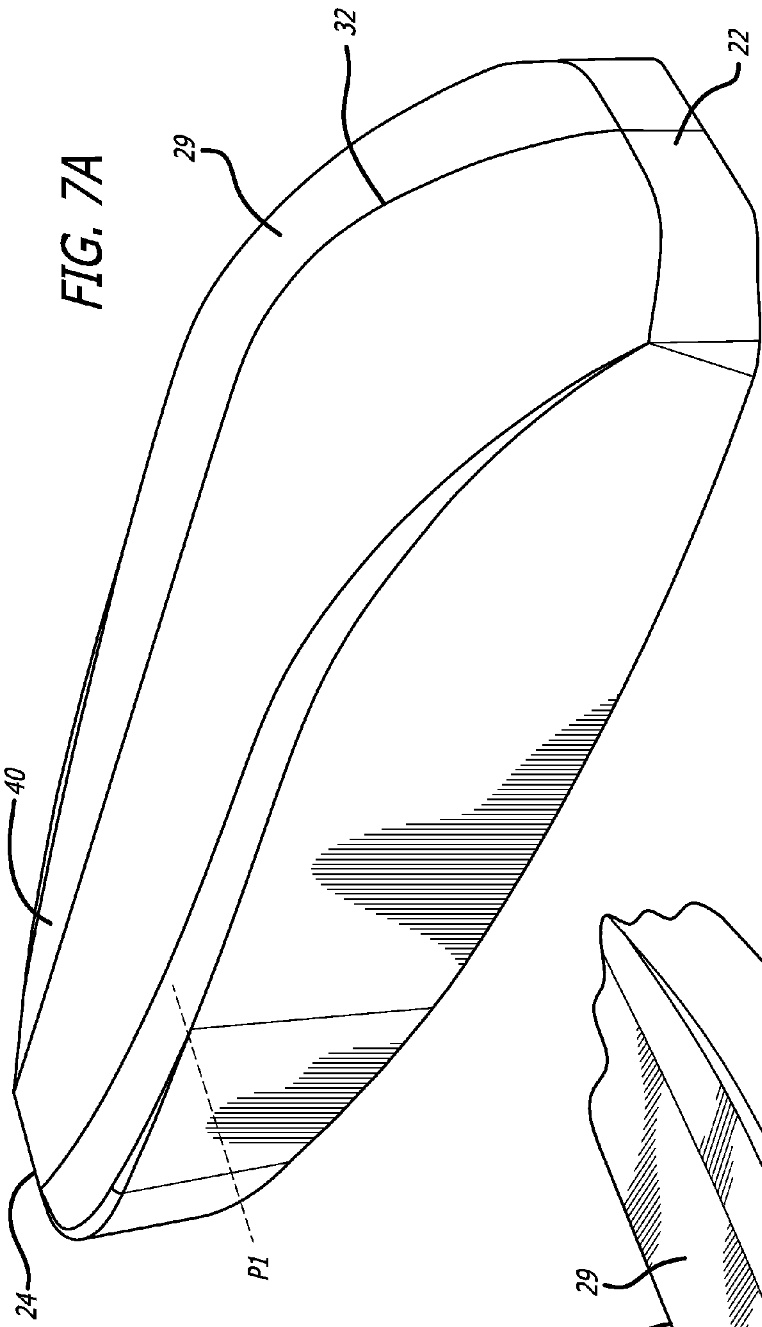
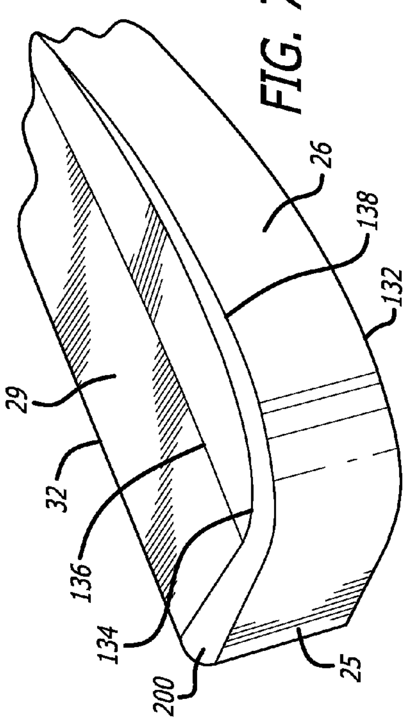
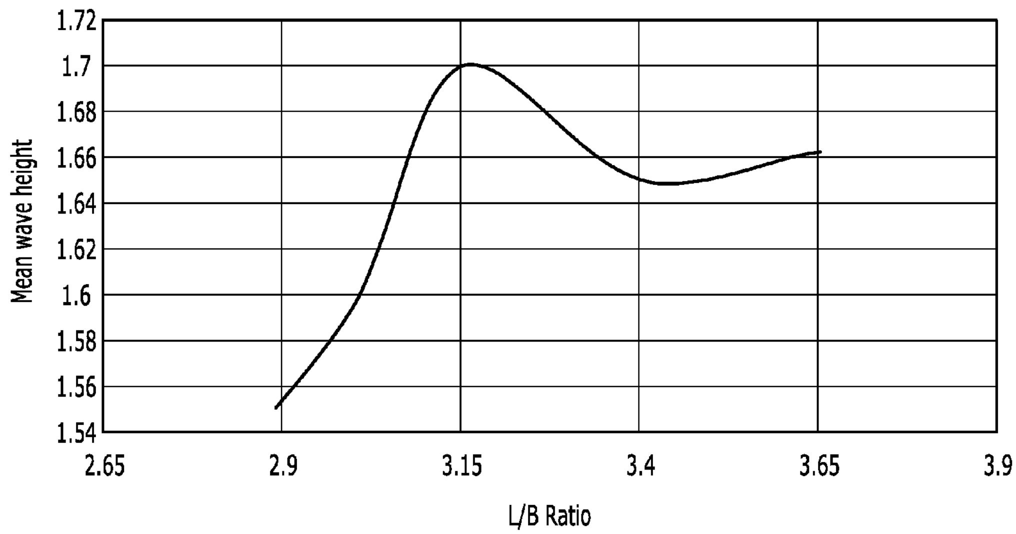


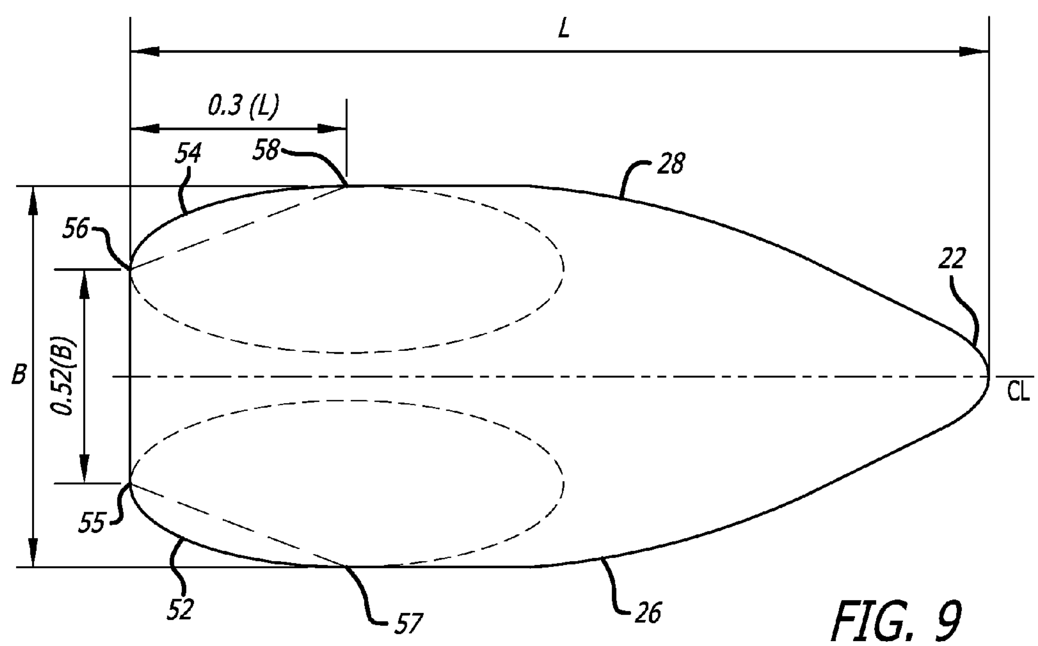
FIG. 7B





1.72
1.7
1.68
1.66
1.64
1.62
1.6
1.58
1.56
1.54
Mean wave height
2.65
2.9
3.15
3.4
3.65
3.9
L/B Ratio

FIG. 8



L
0.3 (L)
54
58
28
56
22
B
0.52(B)
CL
55
52
57
26

FIG. 9

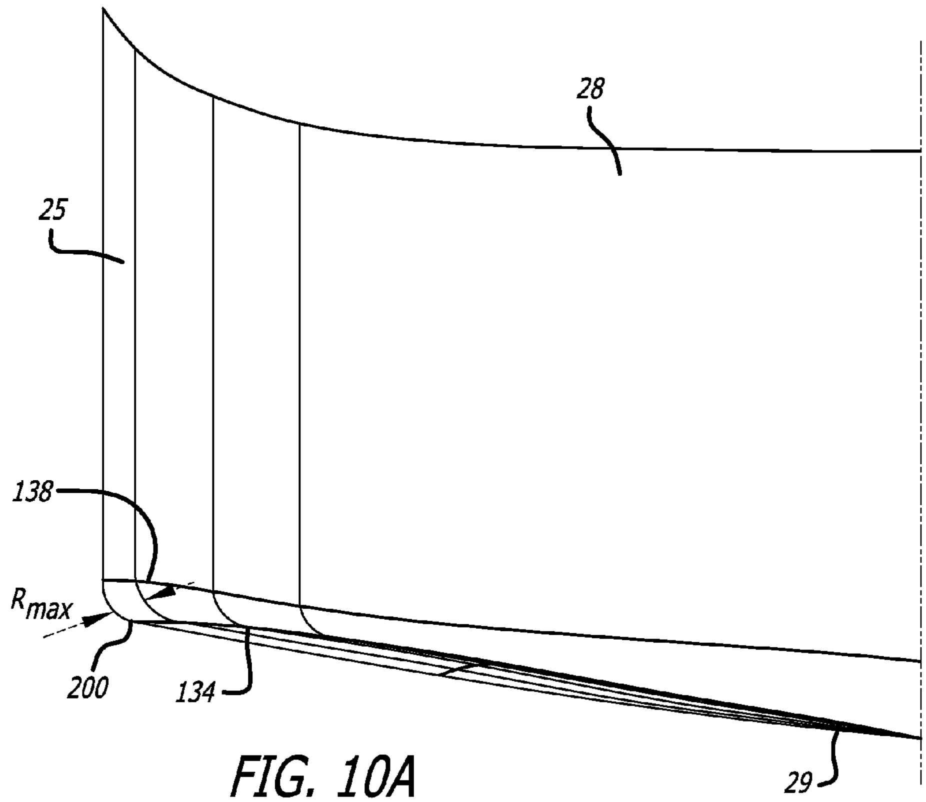


FIG. 10A

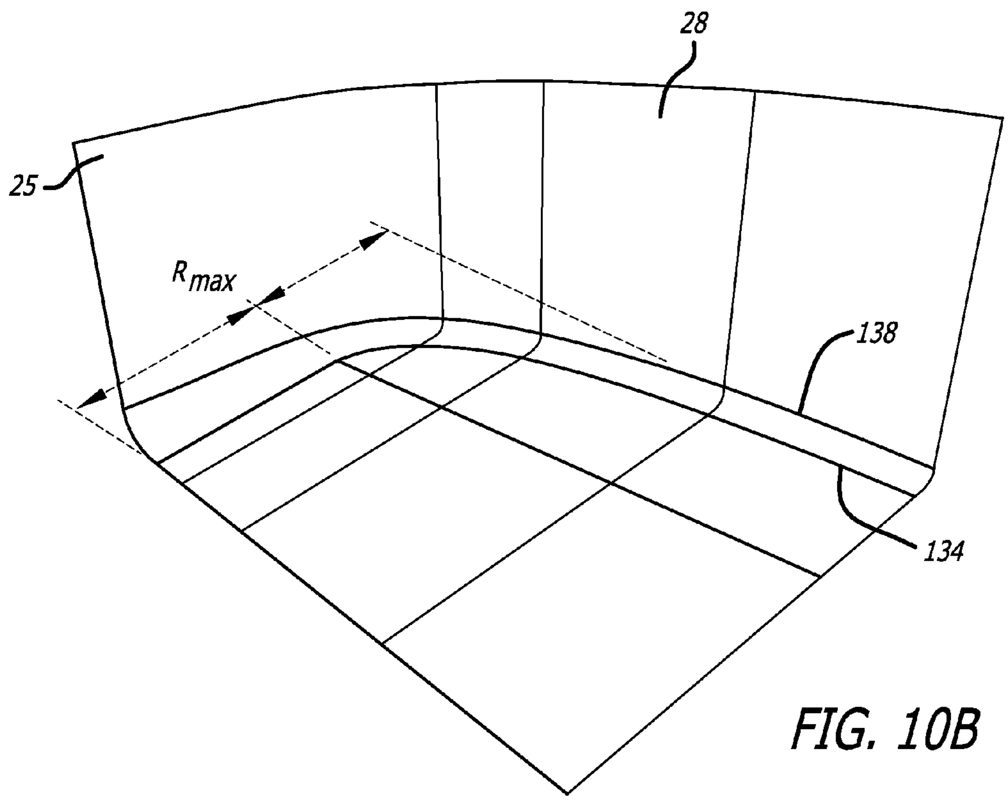


FIG. 10B

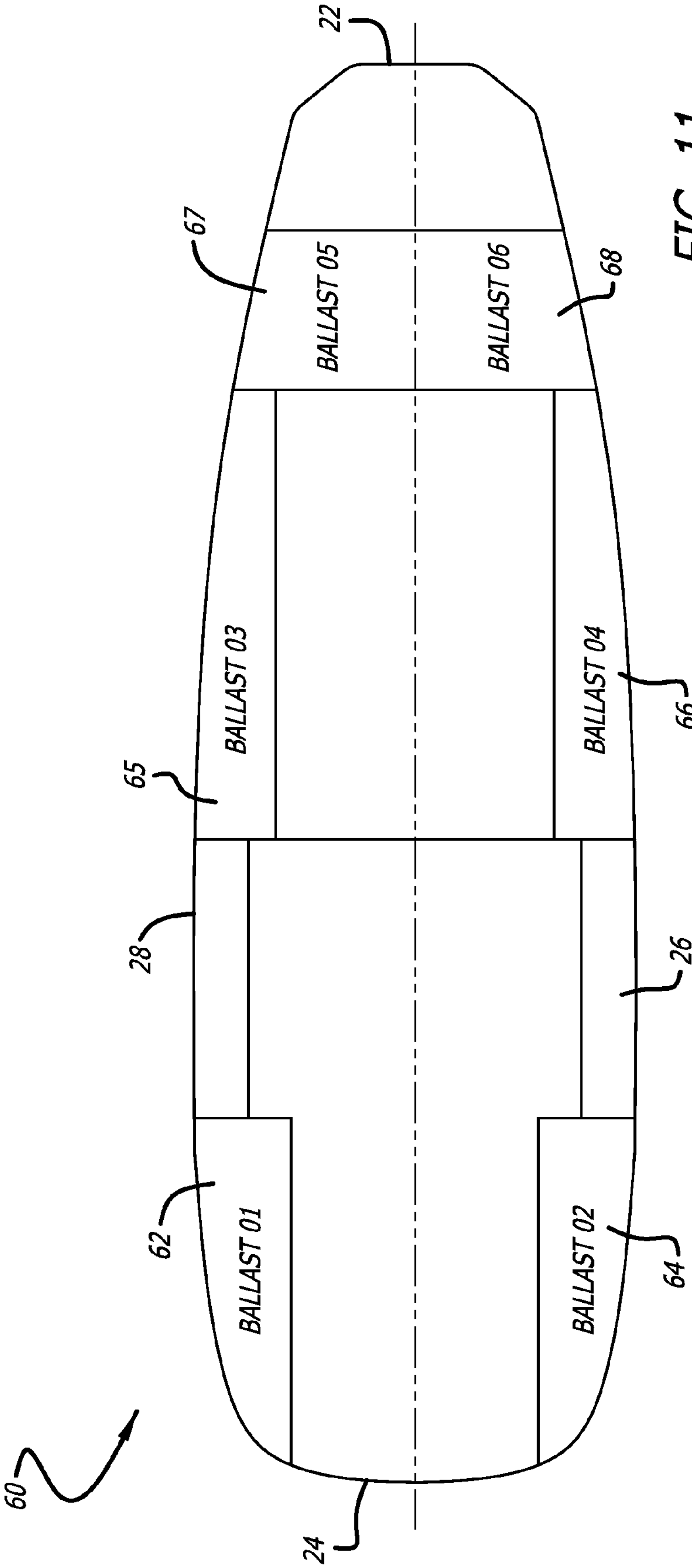

22
67
68
BALLAST 05
BALLAST 06
BALLAST 03
BALLAST 04
65
66
28
26
62
64
BALLAST 01
BALLAST 02
60
24

FIG. 11

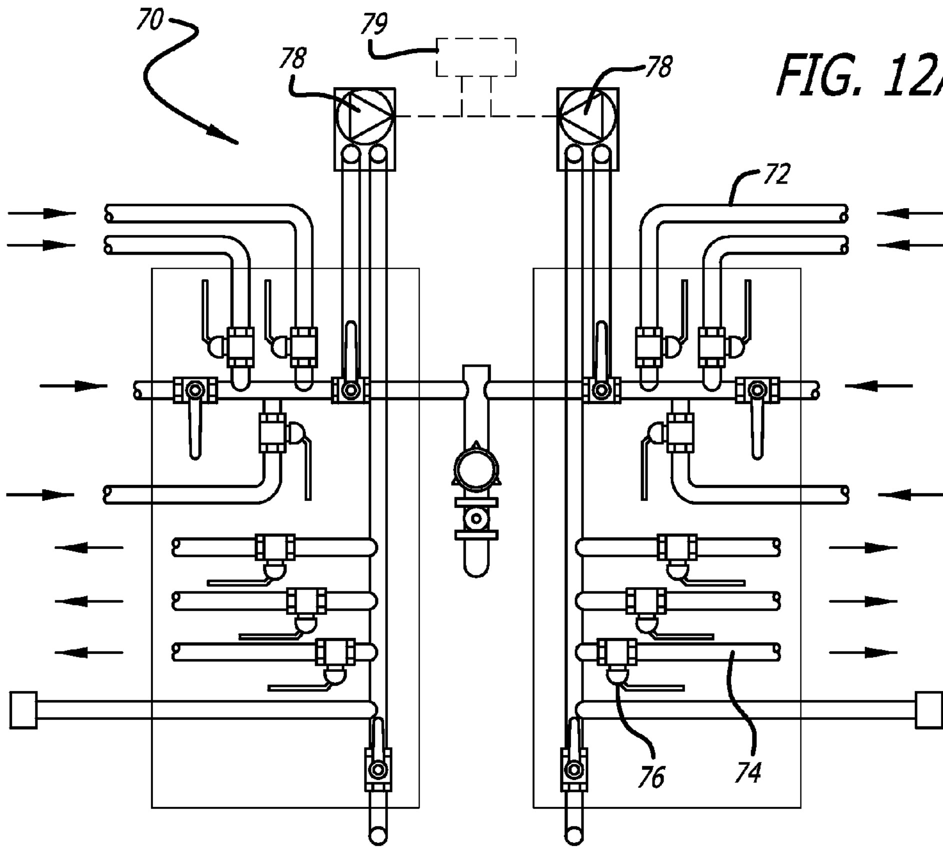


FIG. 12A

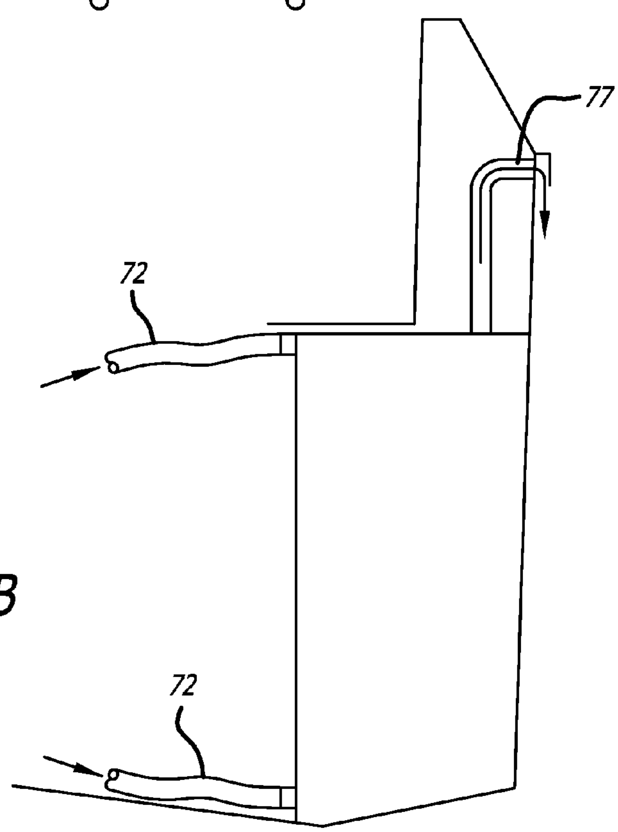


FIG. 12B

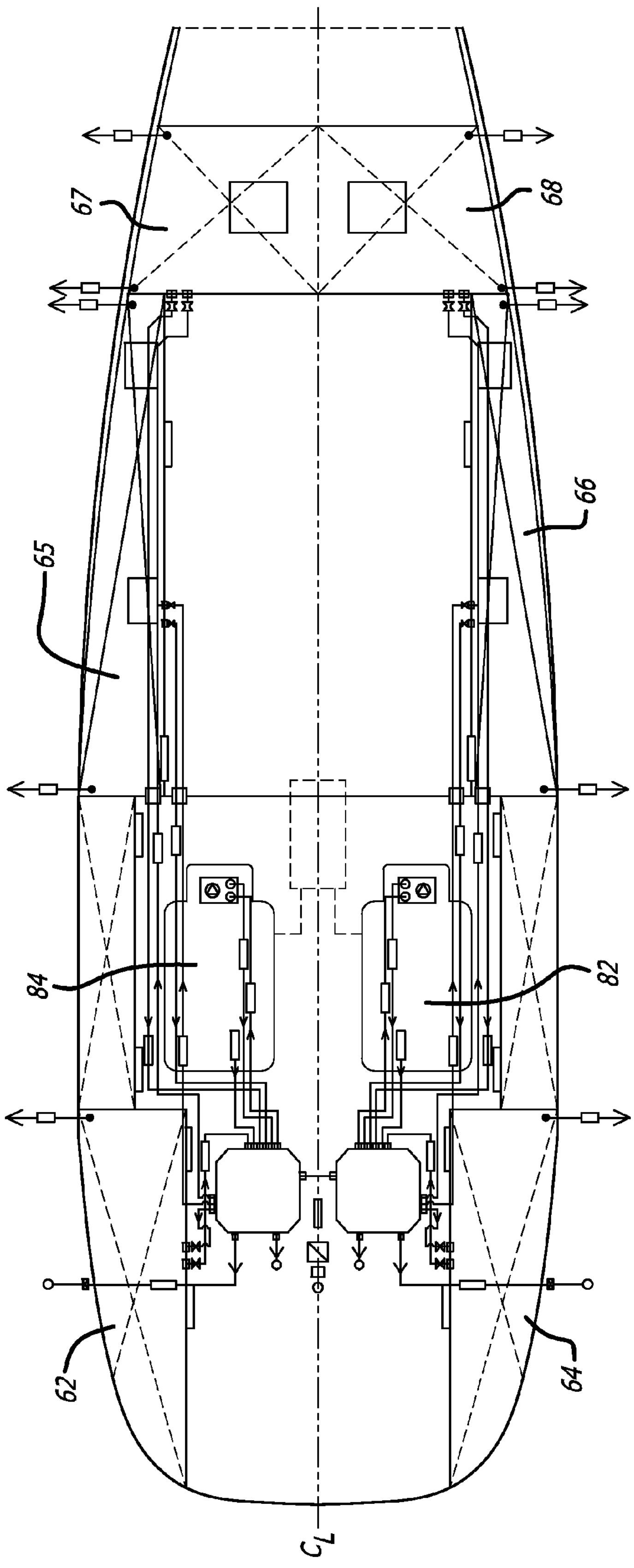
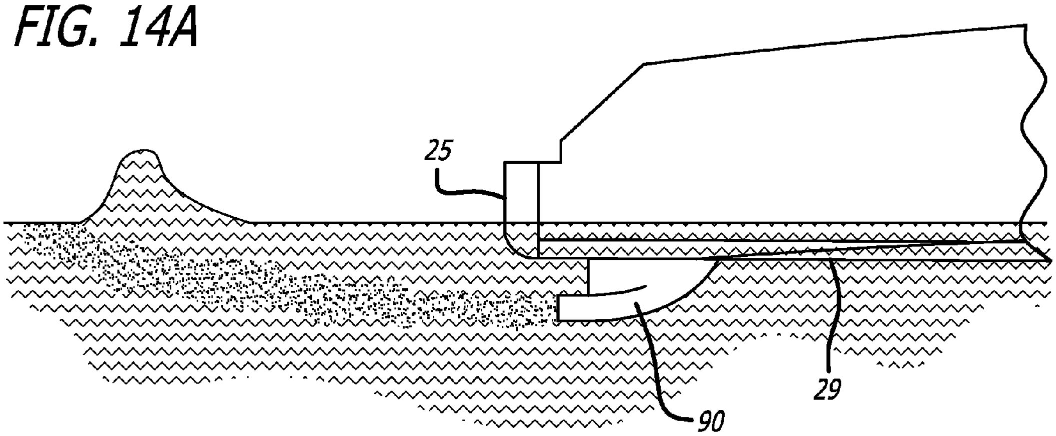


FIG. 13

FIG. 14A



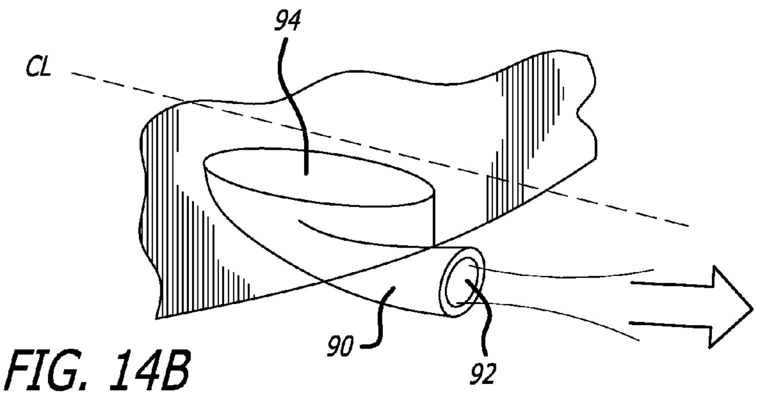


FIG. 14B

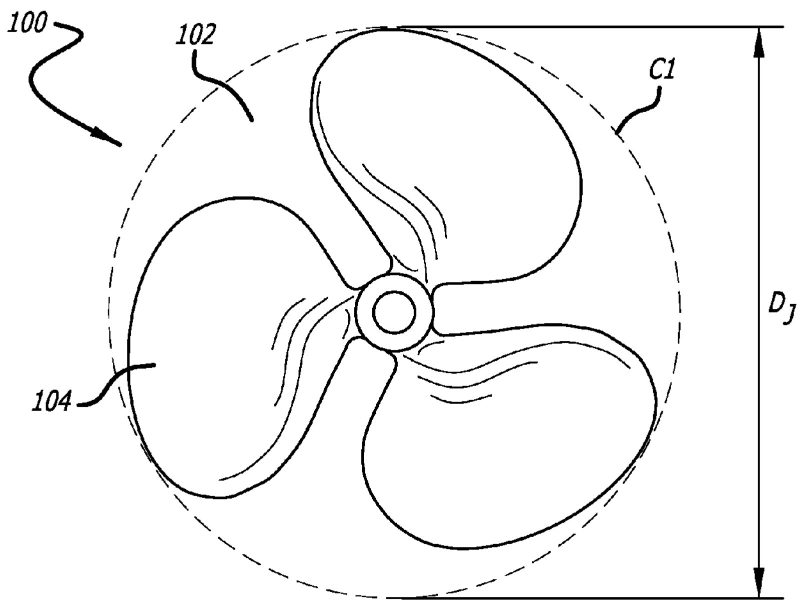


FIG. 15

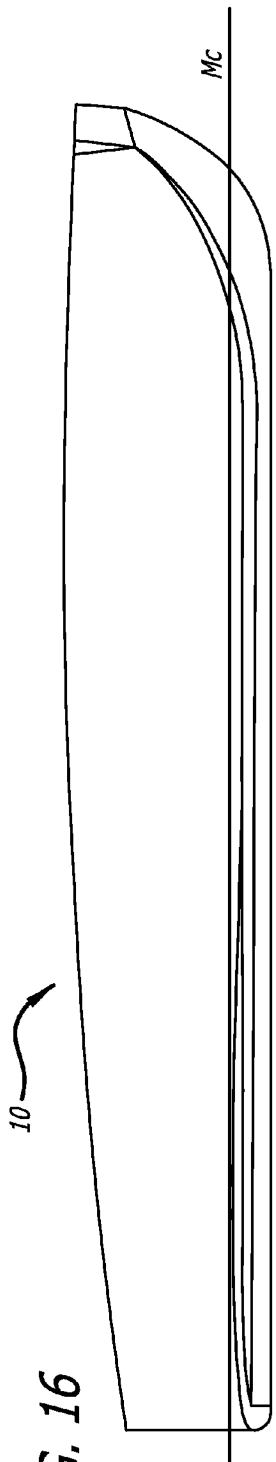


FIG. 16

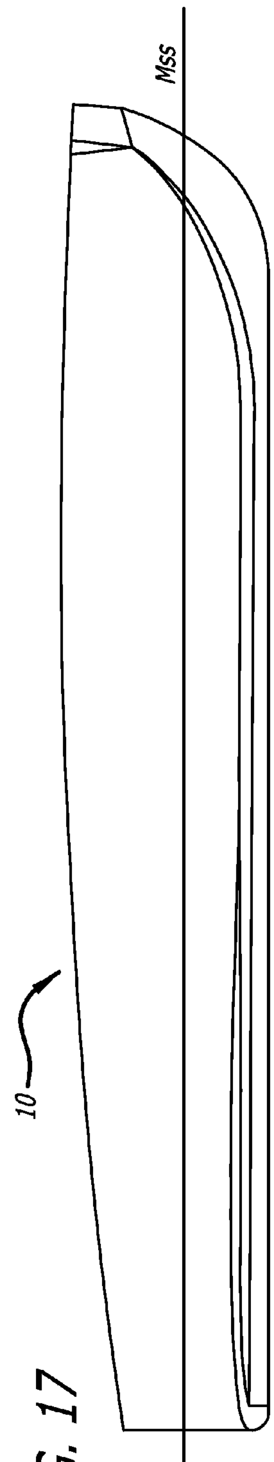


FIG. 17

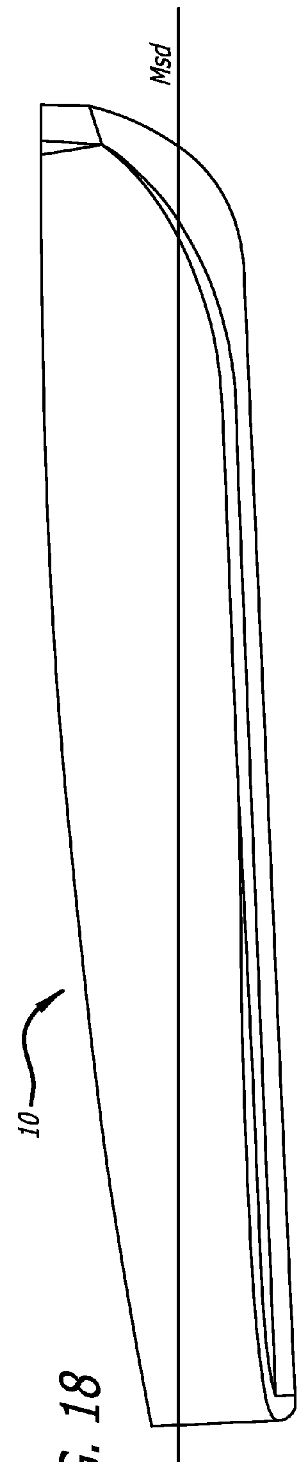


FIG. 18

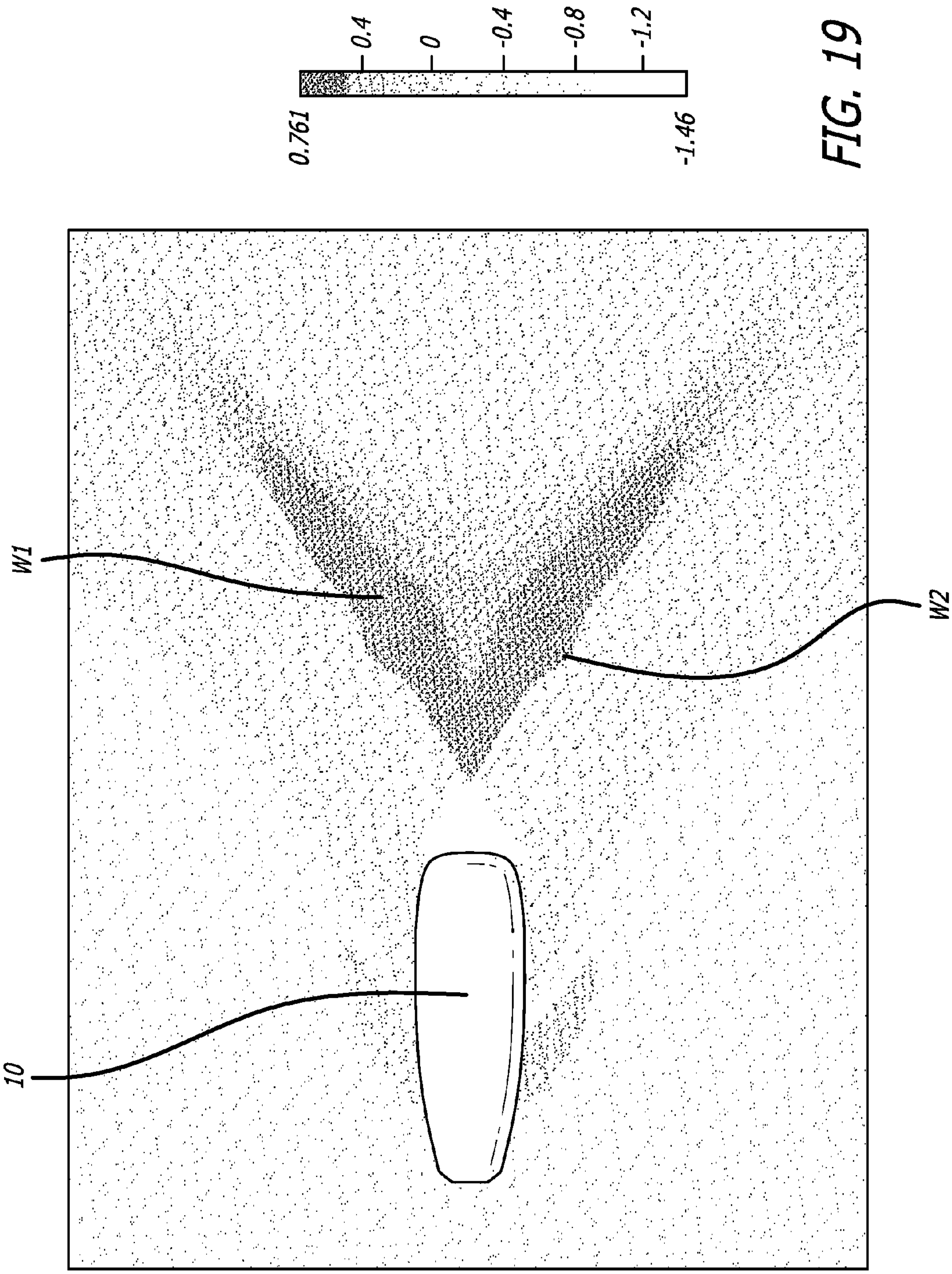


FIG. 19

WAKESURFING BOAT

The present application is a continuation of U.S. application Ser. No. 14/676,305, filed Apr. 1, 2015; all of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

The present invention relates to a wakesurfing boat, having a hull configuration adapted to produce a relatively large, long-lasting, and well-shaped wave in the wake of the boat, on which a wakesurfer can ride on a surf board, similar to surfing on a natural ocean wave.

DESCRIPTION OF THE PRIOR ART

Wakesurfing is a watersport that is rapidly growing in popularity. A wakesurfer, being towed behind a boat, while standing on a surf board and holding onto a tow rope, rides on a wave created in the wake of the boat, similar, in some respects, to a waterskier or a wakeboarder. Ideally, the boat should generate, in its wake, a wave that as closely as possible mimics a size, a shape of a face, a shape of a crest, and a duration, of an ocean wave. If the wake wave reaches a sufficient size, shape, and duration, the wakesurfer, unlike a waterskier or a wakeboarder, can release the tow rope, and ride the surf board on the crest and the face of the wake wave, traversing back and forth on the wake wave, similar to an ocean surfer.

Until now, wakesurfers have been attempting to surf primarily in the wakes of existing cruising boats, waterskiing boats, and wakeboarding boats. A problem with attempting to wakesurf behind such traditional boats, however, is that such boats fail to generate sufficiently large, sufficiently well-shaped, and sufficiently long-lasting wake waves necessary to give the wakesurfer a long, satisfying ride. Traditional boats also release engine exhaust gases into the air in the surfing area in the wake of the boat, causing discomfort to the wakesurfer.

As is known in the field of fluid dynamics, a boat, when passing through a body of water, creates separate waves that move in the boat's wake. In general, separate wake waves originate, respectively, from the boat's bow, centerline, quarter, and stern. Each wake wave generally forms the arms of a V, with the source of the respective wake wave being at the point of the V (i.e., the boat), and transverse curled wave crests forming offset from the path of the boat. Wake wave height is a function of several factors, including for example, a speed of the boat on the surface of the water, resistance to the boat as it moves through the water, a shape of the bottom of the hull, a length of the hull, a length/beam (L/B) ratio of the hull, a speed/length ratio (SLR) of the hull, a Froude number (Fr) of the hull, an amount of the bottom of the hull in contact with the body of water, hull displacement, hull trim, and an efficiency of the boat's propeller at the relatively high loads associated with wake surfing.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a wakesurfing boat that provides, in its wake, a relatively large, relatively long-lasting, and relatively well-shaped wake wave, mimicking as closely as possible an ocean wave, in order to give a wakesurfer a long satisfying surfing experience substantially similar to that of an ocean surfer.

It is another object of the present invention to provide a wakesurfing boat and a hull for a wakesurfing boat capable of

operating in separate modes, including a cruising mode, a static surfing mode, and a dynamic surfing mode.

It is a further object of the invention to provide a wakesurfing boat, configured with a ballast system capable of moving ballast rapidly and efficiently, in order to change the trim and displacement of the boat rapidly and efficiently, to thereby rapidly and efficiently shift the modes of operation.

It is a further object of the present invention to provide a wakesurfing boat configured to maximize wave resistance to the boat and the hull, to transform the power from the engine, and to maximize the efficiency of the propeller, in order to generate as much wave power as possible.

It is a further object of the present invention to provide a wakesurfing boat configured to substantially prevent engine exhaust from being released behind the first wave crest and entering the air in the surfing area aft of the boat, thereby minimizing or preventing discomfort to the wakesurfer caused by the exhaust gases.

These and other objects of the present invention will be apparent from review of the following specification and the accompanying drawings.

In view of the above objectives of the invention, a wakesurfing boat as depicted, disclosed, and claimed below, substantially obviates one or more of the shortcomings of the related art.

A wakesurfing boat includes a hull, the hull having a bow, a stern, a transom positioned at the stern, a starboard bulwark, a port bulwark, a length L between the bow and the stern, a transom positioned at the stern, a beam B between the starboard and port bulwarks, a bottom, and a centerline CL extending between the bow and the stern.

The boat, moving through water, creates a wake with minimum losses when the hull has a L/B ratio of approximately 3.21 with a rounded portion on the hull bottom proximate the transom. The rounded portion defines a fillet between the hull bottom and the starboard and port bulwarks proximate starboard and port points on the transom. The rounded portion on the hull bottom has a maximum radius related to the beam B of approximately 0.04(B).

The hull also has starboard and port arcuate portions defined on the starboard and port bulwarks, respectively, proximate the stern, extending outboard from the respective starboard and port points on the transom forward to respective starboard and port positions on the starboard and port bulwarks. The starboard and port arcuate portions each extend forward a distance equal to approximately 0.3(L). The starboard and port arcuate portions define partial arcs of starboard and port ellipses, each ellipse defined by a major radius equal to 0.2(L) to 0.4(L), preferably 0.3(L) and a minor radius equal to 0.2(B) to 0.3(B), preferably 0.24(B).

The respective starboard and port points on the transom are positioned spaced to starboard and port, respectively, of the CL. Each of the starboard and port points is spaced from the centerline by a distance equal to 0.26(B).

The bottom of the hull defines an M-shaped portion, a V-shaped portion, a generally flat portion where the M-shaped portion meets the V-shaped portion, and a rounded portion proximate the transom.

The M-shaped portion on the hull bottom extends from a position proximate the bow aft to a position located intermediate the bow and the stern, i.e., amidships, and more specifically, 0.4(L) to 0.5(L), measured aft from the bow.

The V-shaped portion on the hull bottom extends from the transom to the amidships position, located approximately 0.4(L)-0.5(L) aft of the bow. At the transom, an angle α is defined by the V-shaped portion of 10°. Angle α of the

V-shaped portion decreases steadily to 7° at the amidships position where the hull bottom begins to transform into the M-shaped portion.

The wakesurfing boat further includes a ballast system and a propulsion system.

The propulsion system includes at least an engine and an exhaust pipe with an exhaust aperture. The exhaust pipe extends below the waterline of the hull and is attached to a wing-shaped body having a full wing profile between the bottom of the hull and the exhaust aperture. The exhaust aperture, through which the engine exhaust gases are omitted, is positioned forward of the transom. As a result of the above combination of structural features, exhaust gases are emitted below the wake wave aft of the transom, not in the air of the surfing area aft of the transom.

The propulsion system further includes a propeller. The propeller has a preselected disc area and a preselected blade area. The preselected blade area is larger than 70% of the preselected disc area.

The boat's ballast system includes a plurality of ballast tanks, piping, and pumps for routing ballast water into the boat, between the ballast tanks, and overboard, as desired by a user of the boat. A controller, operated by a boat operator, controls operation of both the ballast system and the propulsion system. The controller enables the boat operator to selectively change acceleration, speed, ballast, trim, and displacement, in order to operate the wakesurfing boat in different modes of operation, including at least a cruising mode, a static surfing mode, and a dynamic surfing mode.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a wakesurfing boat in accordance with the invention;

FIG. **2** is a top view of the wakesurfing boat in accordance with the invention;

FIG. **3** is a front view of the wakesurfing boat in accordance with the invention;

FIG. **4** is a rear top perspective view of the wakesurfing boat in accordance with the invention;

FIG. **5***a* is a starboard side profile view of the wakesurfing boat in accordance with the invention, depicting locations along the length of the hull of spaced cross-sectional cuts A-O at preselected locations between them stern and the bow, respectively;

FIG. **5***b* is an upper plan view of the wakesurfing boat in accordance with the invention, depicting the location of the spaced cross-sectional cuts shown in FIG. **6**;

FIG. **6** is a body plan view of the wakesurfing boat in accordance with the invention, depicting the relative shape of each of the cross-sectional cuts A-O shown in FIGS. **5***a* and **5***b;*

FIG. **7***a* is a front perspective view of a hull bottom in accordance with the invention;

FIG. **7***b* is an upper perspective view depicting stern details of a hull in accordance with the invention;

FIG. **8** is a graph depicting an optimum length to beam ratio L/B to obtain a large wave using the wakesurfing boat in accordance with the invention;

FIG. **9** is a top view of the hull of the wakesurfing boat in accordance with the invention, proximate the stern, depicting laterally-projecting arcuate portions extending between starboard and port endpoints on the transom to respective starboard and port positions on the respective starboard and port bulwarks, configured to minimize losses from turbulence and speed gradients in the wake, each arcuate portion defining an arc of a respective ellipse;

FIG. **10***a* is a side view of the stern of the wakesurfing boat in accordance with the invention, depicting a rounded stern portion connecting the hull bottom to the starboard bulwark and the transom;

FIG. **10***b* is a side perspective view depicting the rounded stern portion of FIG. **10***a;*

FIG. **11** is a top plan view depicting a preferred location of ballast tanks in the wakesurfing boat in accordance with the invention;

FIG. **12***a* is a plan view depicting system details of ballast pipes and pumps, used with the ballast tanks depicted in FIG. **11** in the wakesurfing boat in accordance with the invention;

FIG. **12***b* is a cross-sectional view of a ballast tank of FIG. **11**, depicting a ballast filling and discharge principle for the ballast tank;

FIG. **13** is a top plan view depicting a portion of a propulsion system in the wakesurfing boat in accordance with the invention, and an interaction of the propulsion system, and the ballast system in the wakesurfing boat in accordance with the invention;

FIG. **14***a* is a side view depicting the configuration of an exhaust pipe in the wakesurfing boat in accordance with the invention, and the location of the exhaust pipe aperture in relation to the transom;

FIG. **14***b* is a perspective view depicting the configuration of the exhaust pipe of FIG. **14***a;*

FIG. **15** is a front view of a propeller used in the wakesurfing boat in accordance with the invention;

FIG. **16** is a side view of a wakesurfing boat in accordance with the invention, in a cruising mode;

FIG. **17** is a side view of a wakesurfing boat in accordance with the invention, in a static surfing mode;

FIG. **18** is a side view of a wakesurfing boat in accordance with the invention, in a dynamic surfing mode; and

FIG. **19** is a top view graphically depicting a wave in the wake of a wakesurfing boat, in accordance with the invention, operating in a dynamic surfing mode.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the attached claims.

In accordance with the invention, and as broadly embodied in FIGS. **1**-**7**, a wakesurfing boat **10**, in accordance with the present invention, includes a hull **20**. The hull **20** includes a bow **22**, a stern **24**, a transom **25** positioned at the stern, a starboard bulwark **26**, a port bulwark **28**, a centerline CL extending between the bow **22** and the stern **24** intermediate the starboard and port bulwarks **26**, **28**, a length L between the bow **22** and the stern **24**, a beam B between the starboard bulwark **26** and the port bulwark **28**, and a hull bottom **29**. In one preferred embodiment, the length L of the hull is 13.37 meters. In one preferred embodiment, the maximum beam B is 4.54 meters. The actual preferred length L and beam B, however, will be selected to achieve a preferred length to beam (L/B) ratio, as discussed below.

In accordance with the invention, and as embodied in FIGS. **3**, **5***a*, **5***b*, **6**, and **7***a*, an M-shaped portion **30** is defined on the hull bottom **29**. The M-shaped portion **30** includes a central vertex **32**, defined by a keel line of the hull, a starboard vertex **34**, a port vertex **36**, a starboard nadir **37**, and a port nadir **38**. Referring to FIGS. **5***a* and **5***b*, the bottom **29** of the hull **20** further includes a sheer line **132**, first and second inner chines **134** and **136** on each of the starboard and port bulwarks, respectively (the chines on the starboard bulwark **26** are shown in FIG. **5***a*, and the chines on the port bulwark **28** are shown in FIG. **5***b*). An outer chine **138** is also defined on each bulwark. The starboard and port vertices **34** and **36** of the M-shaped portion **30** correspond to forward portions of the first inner chines **136**. Referring to FIG. **7***a*, the M-shaped portion **30** extends from the bow **22**, along the bottom **29** of the hull **20**, to a position P**1**, substantially amidships on the bottom **29** of the hull **20**, between 0.4(L), and 0.5 (L) measured aft from the bow. The M-shaped portion **30** increases mass, and consequently increases efficient displacement, by trapping water and building up a bow wave between the starboard vertex **34** and the port vertex **36**. The starboard and port vertices **34** and **36** also divide flow of the surface water under the bottom **29** of the hull **20**, and direct spray towards the center of the bottom **29**, thereby minimizing spray on the bulwarks of the hull **20** in the dynamic surfing mode M_{sd}, thereby increasing the wave quality in the wake, leaving a more clean surface flowing aft, and providing a clean surface area to the wake wave.

In accordance with the invention, and as embodied in FIGS. **6** and **7***a*, a V-shaped portion **40** is defined on the bottom **29** of the hull **20**, extending from the transom **25** to the amidships position P**1** where the bottom transforms into the M-shaped portion **30**. The V-shaped portion **40** defines an angle α of 10° at the transom **25**. Angle α decreases steadily along the length of the V-shaped portion **40** until it reaches an angle of 7° at amidships position P**1**. The transition of the V-shaped portion **40** to the M-shaped portion **30** at position P**1** results in a section of the hull bottom which is relatively flat and nearly rectangular, a configuration which is beneficial for carrying an amount of ballast needed when the boat operates in the dynamic surfing mode M_{sd}. At the position P**1**, the outer chine **138** transforms into a forward outer chine portion, and an aft outer chine portion. In addition, at position P**1**, the first inner chine **134** converts into a forward first inner chine portion, and an aft first inner chine portion. Likewise, at position P**1**, the second inner chine **136** transforms into a forward second inner chine portion, and an aft second inner chine portion. The starboard and port forward second inner chine portions correspond to the starboard and port vertices **34** and **36**, respectively, of the M-shaped portion **30**. The combination of these bow, stern, and mid-hull configurations contributes to the capability of the hull **20** to carry a large quantity of ballast, and a wake wave having relatively high quality, quantified in height, steepness, and smoothness of the wave crest and wave face. The 10° angle at the transom **25** also assists in the creation of a large surfing wave.

In accordance with the invention, the hull **20** includes a preferred length to beam ratio L/B. As embodied in FIG. **8**, a preferred L/B ratio is 2.9 to 3.65, preferably 3.1 to 3.3, and most preferably, in accordance with the invention, 3.21. The optimum L/B ratio of 3.21, with a rounded hull bottom proximate the transom, results in a closed wake wave. The closed wake wave meets a "rooster tail" of the wake, producing a diverging wake wave, with wave components W**1** and W**2** on starboard and port sides of the boat, respectively, as shown in FIG. **19**. This optimum LIB ratio, combined with the rounded hull bottom proximate the transom, also results in the wake wave having minimum losses.

As broadly embodied in FIGS. **5***a*, **5***b*, **7***b*, **10***a*, and **10***b*, a rounded portion **200**, between the aft portion of the first inner chine **134** and the aft portion of the outer chine **138**, is defined on the bottom **29** of the hull **20**, proximate the transom **25**, thereby defining a fillet between the bottom **29** and the respective starboard and port bulwarks **26** and **28** at starboard and port points **55** and **56** defined on the transom **25**. Each of the starboard and port points **55** and **56** on the transom **25** are located, respectively, spaced to starboard and port of the centerline CL by an amount equal to 0.26(B), defining a total distance between the transom points **55** and **56** of 0.52(B). In a preferred embodiment, the rounded portion **200**, as depicted in FIG. **10***a*, has a maximum radius relative to the beam B of 0.03(B) to 0.05(B), and most preferably 0.04(B). In the presently preferred embodiment, this maximum radius of 0.04(B) is equal to 154 mm. The rounded portion **200**, combined with the preferred L/B ratio of 3.21 minimizes losses due to turbulence in the wake wave.

To further minimize losses in the wake wave from turbulence and large speed gradients, and in accordance with the invention, a portion of the aft hull body, proximate the stern **24**, in a horizontal plane, is rounded, with the rounded aft hull body intersecting the transom **25** and the starboard and port bulwarks **26** and **28** of the hull **20**. In accordance with the invention, and as broadly embodied in FIG. **9**, the hull **20** includes starboard and port arcuate portions **52** and **54**, extending outboard from the respective starboard and port points **55** and **56** on the transom. The starboard and port arcuate portions **52** and **54** have generally partially-elliptical shapes each arcuate portion defining a partial arc of a respective starboard and port ellipse proximate the transom **25**, as depicted in FIG. **9**, each of the ellipses being defined by a major radius equal to 0.2(L) to 0.4(L), preferably 0.3(L), and a minor radius equal to 0.2(B) to 0.3(B), preferably 0.24(B). The starboard and port arcuate portions **52** and **54** extend from the starboard and port transom points **55** and **56**, forward to respective starboard and port positions **57** and **58** on the starboard and port bulwarks **26** and **28** of the hull **20**. A preferred distance that the starboard and port arcuate portions **52** and **54**, respectively, extend from the respective starboard and port transom points **55** and **56**, to the respective starboard and port bulwark positions **57** and **58** is between 0.2(L)-0.4 (L), preferably 0.3(L). The outboard rounding of the bulwarks **26** and **28** proximate the transom **25** increases the amount that the hull **20** sinks during the dynamic surfing mode M_{sd}, thereby increasing hull displacement and resultant wake wave height.

In accordance with the invention, and as broadly embodied in FIG. **11**, a ballast system **60** preferably includes six (6) ballast tanks, including a first ballast tank **62**, a second ballast tank **64**, a third ballast tank **65**, a fourth ballast tank **66**, a fifth ballast tank **67**, and a sixth ballast tank **68**, positioned at alternating positions above the hull bottom **29**, adjacent the starboard and port bulwarks **26** and **28**, between the stern **24** and the bow **22**. FIG. **10** also depicts the position of the center of buoyancy CB of the hull **20**. Preferably, the first ballast tank **62** has a total capacity of 2,549 liters, a longitudinal center of gravity (LCG) of 1.81 meters, a vertical center of gravity (VCG) of 0.59 meters, and a transverse center of gravity (TCG) of 1.59 meters. Preferably, the second ballast tank **64** has a total capacity of 2,549 liters, an LCG of 1.81 meters, a VCG of 0.59 meters, and a TCG of −1.59 meters. Preferably, the third ballast tank **65** has a total capacity of 2,910 liters, an LCG of 7.65 meters, a VCG of 0.69 meters, and a TCG of 1.63 meters. Preferably, the fourth ballast tank **66** has a total capacity of 2,910 liters, an LCG of 7.65 meters, a VCG of 0.69 meters, and a TCG of −1.63 meters. Preferably, the fifth ballast tank **67** has a total capacity of 1,975 liters, an LCG of 10.72 meters, a VCG of 0.87 meters, and a TCG of 0.79 meters. Preferably, the sixth ballast tank **68** has a total capacity of 1,975 liters, an LCG of 10.72 meters, a VCG of 0.87 meters, and a TCG of −0.79 meters.

As further broadly embodied in FIGS. **12a** and **12b**, the ballast system **60** includes a ballast tank piping and pumping system **70**. The ballast tank piping and pumping system **70** includes a plurality of ballast tank filling pipes **72**, a plurality of ballast tank discharge pipes **74**, and overflow vent pipes **77**, with each of the various pipes **72**, **74**, **75**, and **77** being associated with respective ballast tanks. In addition, the ballast tank piping, pumping, and control system **70** includes associated flow regulation valves, throttle valves, choke valves, and gate valves **76**, ballast water pumps **78**, and a controller **79**. The controller **79** enables the operator of the wakesurfing boat **10** to manually or automatically control operation of the pumps **78** and valves **76**, in order to selectively fill and drain various ballast tanks as desired. The configuration, and the principles of operation, of the automatically-controlled ballast piping and pumping system **70** are conventional, and known to persons of ordinary skill in the art, and therefore will not be further discussed here.

In accordance with the invention, and as broadly embodied in FIGS. **12-13**, a propulsion system **80** includes starboard and port engines **82** and **84**, an engine exhaust discharge pipe **90**, a propeller shaft (not shown), and a propeller **100**. The controller **79**, operated by the boat operator, in addition to controlling the ballast tank piping and pumping system **70**, also controls the main engines **82** and **84** to regulate the speed of the wakesurfing boat **10**. The speed of the wakesurfing boat **10**, in combination with the ballast tank load, and the resultant trim and displacement of the wakesurfing boat **10**, results in an ability to operate the boat **10** in different modes of operation, as explained below.

In accordance with the invention, and as broadly embodied in FIG. **12**, the engine exhaust discharge pipe **90** extends from the transom **25** below the hull bottom **29** and offset from the centerline CL, with an exhaust opening **92** being defined in the exhaust pipe 100 mm forward of the transom **25**. The exhaust from the engines **82** and **84**, as a result, is released submerged in the water, and is carried aft in the wake wave aft of the hull **20**, rather than being released and carried aft in the air aft of the hull **20**. It is preferred that at least one wing-shaped portion **92** be attached to the exhaust pipe **90** between the exhaust pipe **90** and the hull bottom **29**. The at least one wing-shaped portion **92** preferably has a portion with a height of approximately 120-150 mm, and a length approximately 4-5 times an outer diameter of the exhaust opening **92**. The above-described combination of structural features results in the wake wave closing above the exhaust gasses, thereby not allowing the exhaust gases to exit the water into the air in the wake of the boat **10**, and hence avoiding discomfort to the wakesurfer.

In accordance with the invention, and as broadly embodied in FIG. **15**, the propulsion system **80** includes a propeller **100**. The propeller **100** includes a hub and at least three propeller blades **104**. The hub and the blades define a disc **102**. The disc **102** defines a first circle C_1 having a first diameter D_1, and a first area $A_1=(\pi/4)D_1^2$. The total area of the blades **104** defined by the projected blade area on the surface of the disc **102**, defines a second area A**2**. Propulsion in the dynamic surfing mode M_{sd} (discussed below) requires high efficiency at high load on the propeller. In the dynamic surfing mode M_{sd}, the propeller **100** needs to propel the boat **10** up to an optimum surfing speed. This requires a large thrust at a relatively low speed, thereby placing a high load on the blades **104**. Transmission of maximum thrust and power to the water requires a large blade area. In addition, if the blade area is too small, the water is unable to carry the load and will start to cavitate in the wake, reducing propeller efficiency and thrust. Wakesurfing boat **10**, in accordance with the invention, operating in the dynamic surfing mode M_{sd}, with a large amount of ballast, enjoys maximum thrust and propeller efficiency because the second area A_2, defined by a sum of the area of the projected area of the blades **104**, is larger than 70% of the first area A_1 of the first circle C_1 defined by the disc **102**. Use of a ducted propeller as the propeller **100** also is contemplated and within the scope of the invention.

As embodied in FIGS. **16-19**, interaction of the ballast system and the propulsion system, with resultant changes in ballast volume, ballast weight, and boat displacement and trim, results in at least three different modes of operation for the wakesurfing boat **10**, i.e., a cruising mode M_c (FIG. **16**), with the ballast tanks empty, and the boat **10** being propelled through the surface water; a static surfing mode Mss (FIG. **17**), with the ballast tanks in the process of filling, or full, and the boat **10** sitting static in the surface water; and the dynamic surfing mode M_{sd} (FIG. **18**), with the ballast tanks full, and the boat **10** being propelled through the surface water. In the dynamic surfing mode M_{sd}, as a result of the greater hull displacement, greater propeller thrust, greater propeller efficiency, optimized L/B ratio, and minimized losses in the wake resulting from the rounded aft hull bottom and the rounded aft body hull, intersecting with the transom and the bulwarks, a wake wave is created with an improved height, steepness, crest smoothness, face smoothness, and duration, all of which are very desirable for surfing. FIG. **19** graphically depicts a wave in the wake of the above-described preferred embodiment of the wakesurfing boat **10**, in accordance with the invention, including a starboard wave component W**1** and a port wave component W**2**, created by the wakesurfing boat **10** operating in the dynamic surfing mode M_{sd}. Each of the wake wave components W**1** and W**2** defines a relatively large, relatively long-lasting, and relatively well-shaped wake wave, mimicking as closely as possible an ocean wave, thereby providing the wakesurfer a long satisfying surfing experience substantially similar to that of an ocean surfer.

What is claimed is:

1. A wakesurfing boat comprising:

a hull, the hull comprising:

- a bow;
- a stern;
- a transom positioned at the stern;
- a starboard bulwark;
- a port bulwark;
- a centerline extending between the bow and the stern midway between the starboard and port bulwarks;
- a bottom;
- a length L between the bow and the stern;
- a beam B between the starboard and port bulwarks
- a keel on the bottom;
- starboard and port inner and outer chines on the bottom, the starboard and port inner and outer chines including at least a first inner chine and an outer chine proximate the transom;
- a rounded portion defined on the bottom between an aft portion of the first inner chine and an aft portion of the outer chine proximate the transom, the rounded portion defining a fillet between the bottom and the starboard and port bulwarks proximate starboard and port points on the transom, the starboard point on the transom being spaced to starboard of the centerline by an amount equal to approximately 0.26(B), the port point on the transom being spaced to port of the centerline by an amount equal to approximately 0.26 (B); and
- a length to beam ratio L/B of between 3.1 to 3.3;

a ballast system; and

a propulsion system.

2. The wakesurfing boat of claim 1, wherein the L/B ratio is 3.21.

3. The wakesurfing boat of claim 1, wherein a maximum radius of the rounded portion relative to the beam B is 0.03 (B) to 0.05 (B).

4. The wakesurfing boat of claim 3, wherein the maximum radius of the rounded portion relative to the beam B is 0.04 (B).

5. The wakesurfing boat of claim 1, wherein the bottom includes at least a substantial M-shaped portion and a substantial V-shaped portion.

6. The wakesurfing boat of claim 5, wherein the substantial M-shaped portion includes a peak portion defined by the keel, and starboard and port vertices defined by forward portions of the starboard and port inner chines.

7. The wakesurfing boat of claim 1, further comprising starboard and port arcuate portions extending from starboard and port points on the transom to respective starboard and port positions on the respective starboard and port bulwarks.

8. The wakesurfing boat of claim 7, wherein a length of each of the respective starboard and port positions on the respective starboard and port bulwarks measured from the respective starboard and port points on the transom is equal to 0.2(L) to 0.4(L).

9. The wakesurfing boat of claim 8, wherein the length of each of the respective starboard and port positions on the respective starboard and port bulwarks measured from the respective starboard and port points on the transom is equal to 0.3(L).

10. The wakesurfing boat of claim 5, wherein the substantial M-shaped portion on the bottom extends along the hull bottom from a first position on the bottom proximate the bow to a second position on the bottom located approximately 0.4(L) to approximately 0.5(L) aft of the bow.

11. The wakesurfing boat of claim 10, wherein the substantial V-shaped portion on the bottom extends from the stern to the second position on the bottom.

12. The wakesurfing boat of claim 1, wherein the rounded portion defined on the bottom proximate the transom defines a fillet between the bottom, the transom, and the respective starboard and port bulwarks.

13. The wakesurfing boat of claim 1, wherein the propulsion system comprises at least an engine, an exhaust pipe with an exhaust opening, and a propeller.

14. The wakesurfing boat of claim 13, wherein the exhaust pipe is attached to a wing-shaped body depending from the bottom and submerged below the transom, the exhaust opening being defined in the exhaust pipe spaced forward of the transom.

15. The wakesurfing boat of claim 13, wherein the propeller has a preselected blade area and a preselected disc area, the preselected blade area being larger than 70% of the preselected disc area.

16. The wakesurfing boat of claim 1, wherein the ballast system comprises a plurality of ballast tanks adapted to hold selected amounts of ballast water, a plurality of pipes, pumps, and valves adapted to transfer the ballast water inboard, overboard, and between the plurality of ballast tanks.

17. The wakesurfing boat of claim 1, further comprising a controller for controlling the ballast system and the propulsion system.

18. The wakesurfing boat of claim 17, wherein the controller is adapted to control the ballast system and the propulsion system to operate the wakesurfing boat in at least one of a cruising mode, a static surfing mode, and a dynamic surfing mode.

19. The wakesurfing boat of claim 1, wherein the rounded portion defined on the bottom has a maximum radius of between approximately 0.03(B) to approximately 0.04(B).

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